Space Weather Technical Forecast

Issued on Friday, 20 January 2023 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further R1/R2 Radio Blackouts likely. Slight chance of G1/Minor Geomagnetic Storms through to day 2 (21 Jan).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate through the past 24 hours, with background C-class emissions and three M1 flares observed, peaking at M1.8 at 19/1012UTC emanating from AR3196 (Cro/Beta). This is a small region located in the northeast, with the same region producing a smaller M1 flare six hours earlier. The other M1 flare emanated from the remnants of ex-3188 in the southwest of the disc at 19/1027UTC.

No new Earth-directed CMEs have been observed in available coronagraph imagery, though we await imagery related to two recent filament lift offs in the northern hemisphere.

Solar Wind / Geomagnetic Activity: Solar wind speeds were mainly ambient to slightly elevated in the range 350-450km/s, with density largely average. The IMF increased a little after 19/0400UTC reaching moderate levels, peaking around 10 nT. The north-south component was mostly weakly positive (northward), though with some more sustained negative (southward) orientations between 19/0300UTC and 19/1300UTC, peak -8 nT. The phi angle was predominately positive (away from the Sun). Geomagnetic activity was largely Quiet (Kp 0-2), with Potsdam and NOAA/SWPC recording an Unsettled period 19/0600-0900UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.

High energy electron flux (greater than 2 MeV) has been at background levels. The 24-hour integrated electron fluence stayed below the Active threshold on a downward trend, with 2.68e6 integrated pfu observed at 19/2359 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain Moderate, with a slight chance of reaching High levels over the next four days. There are numerous regions on the disc, but the most obvious candidates for a significant flare remain AR3190 and AR3192.

Solar Wind / Geomagnetic Activity: Solar winds currently at background levels. A HSS associated with coronal hole 68 may connect with Earth during day 1 (20 Jan) into day 2 (21 Jan), this could potentially increase solar wind speeds to elevated levels, although this is low confidence. No CMEs currently feature in the forecast, though we await imagery related to two recent filament lift offs in the northern hemisphere, provisionally a significant earth direct component looks unlikely.

Geomagnetic activity is expected to be Quiet to Unsettled with isolated Active intervals possible, and a Slight Chance of isolated G1/Minor Storm intervals through to day 2 (21 Jan), lowering as

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any HSS effects start to wane.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly background levels, but with a slight chance of reaching S1 or greater through the period.

High energy electron flux is likely to remain at background to moderate levels for much of the period, with a possible increase later in the period. As such, electron fluence is likely to stay below the Active threshold for much of this period, but with an increasing trend.

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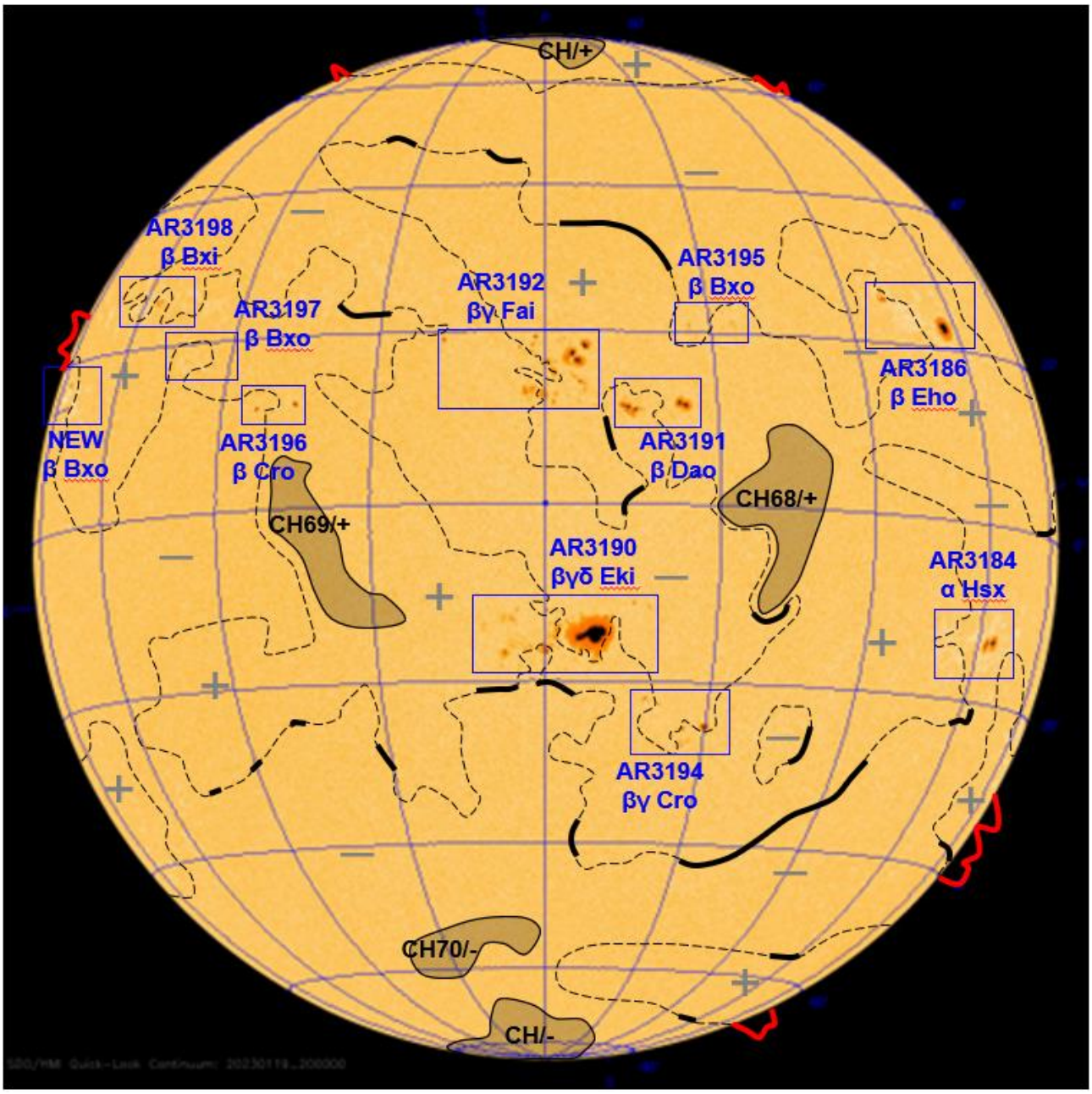
Figure 1. Solar Analysis Valid 19/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Any impact from the CME that was launched on 14 January looks to have passed with solar winds at background levels, though both ACE and DSCOVR data has been reporting erratically, perhaps due to below average density. A HSS associated with coronal hole 68 may connect with Earth during day 1 (20 Jan) into day 2 (21 Jan), this could potentially increase solar wind speeds to elevated levels, 500-600km/s. However, this coronal hole appears to be a much weaker feature than on the previous rotation, so the likely magnitude of associated solar winds is uncertain and likely lower with ENLIL output currently performing poorly with this feature and the usefulness of persistence data open to question.

No CMEs currently feature in the forecast, though we await imagery related to two recent filament lift offs in the northern hemisphere, provisionally a significant earth direct component looks unlikely.

Geomagnetic activity is expected to be Quiet to Unsettled with isolated Active intervals possible, and a Slight Chance of isolated G1/Minor Storm intervals through to day 2 (21 Jan), lowering as any HSS effects start to wane.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	20	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity – Earthbound Coronal Mass Ejections

Nil.

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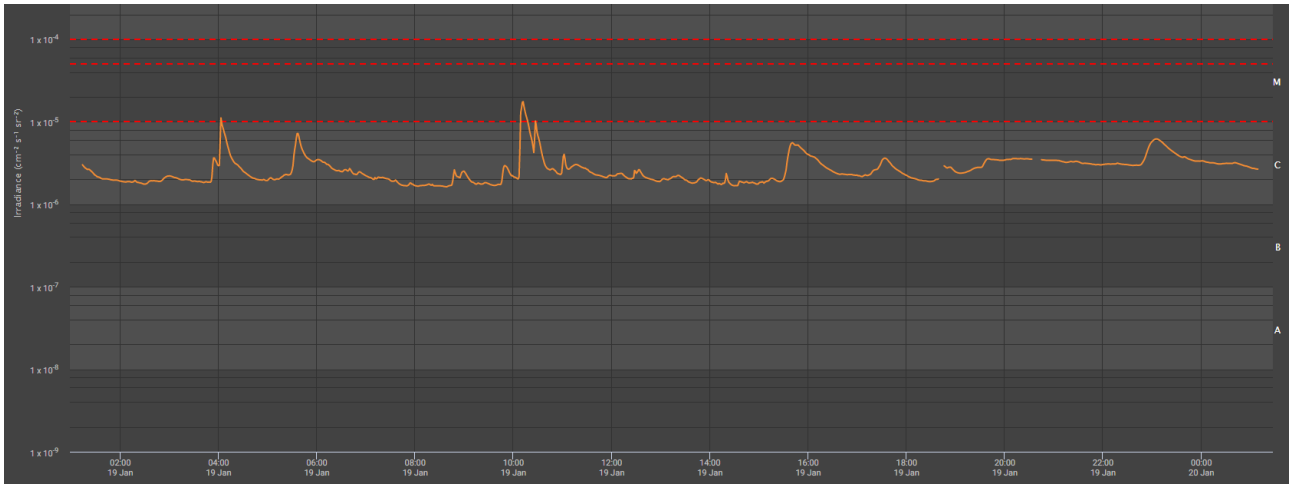
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate through the past 24 hours, with three M1 flares observed, peaking at M1.8 at 19/1012UTC emanating from AR3196 (Cro/Beta). This is a small region located in the northeast, with the same region producing a smaller M1 flare six hours earlier. The other M1 flare emanated from the remnants of ex-3188 in the southwest of the disc at 19/1027UTC.

Solar activity is expected to remain Moderate, with a slight chance of reaching High levels throughout as the most complex regions continue to rotate west.

The visible disk remains active with currently ten numbered and one un-numbered sunspot regions. The largest region remains AR3190 (Eki/Beta-Gamma-Delta) centre disc in the southern hemisphere, and this are continues to see minor development. The other relatively large and complex region is AR3192 (Fai/Beta-Gamma), also centre disc but in the north, with the remaining regions smaller and appearing either stable or in slight decay, though AR3194 in the southwest has seen recent development. Far-side soundings suggest further active regions are likely to rotate onto the northeast limb of the disc in the coming days, further complicating the picture and helping to maintain the risk of flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	65	60	60	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 2: GOES18 X-ray trace over the last 24hr.



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux is currently at background levels.
While no recent S1+ events have been observed at GEO, the sheer number of both front and far-sided complex groups dictates an elevated risk. While the relative contribution to the risk will decrease through the coming days for Ex-3182, both AR3190 and AR3192 bring an increasing risk as they rotate westwards. As such, a slight chance of S1 or greater continues through this four day period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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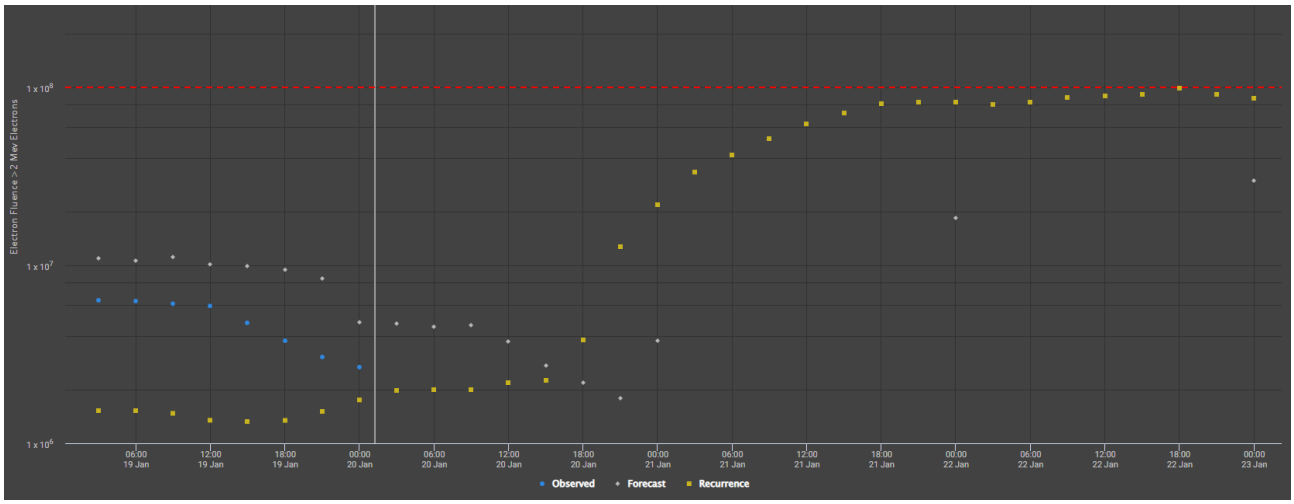
High Energy Electrons Event (≥ 2MeV):
High energy electron flux remains at background to moderate levels. The possibility of a HSS arrival on day 1 (20 Jan) may act to suppress flux even further. An increase is then possible later in the period, once any HSS effects have begun to wane. It is difficult to judge the likelihood of significant electron charging occurring during this period until we see the strength of any HSS, however, so confidence in this is low.

As such, electron fluence is likely to stay below the Active threshold for much of this period, but with an increasing trend into Day 4. MOSWOC REFM is showing a level trend through the next 3 days, which is reasonable.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	15	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output



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